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Ectozoochory by Hares *(Lepus crawshayi)* in Queen Elizabeth National Park, Uganda

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ABSTRACT

Ninety-six hares, *Lepus crawshayi,* were shot and examined for plant propagative disseminules. Sixty-four of them carried plant disseminules belonging to 22 species. A total of 436 disseminules were extracted by vigorously combing the furs. Three hundred and twenty-three of the disseminules belonging to 14 plant species were on 36 female hares and 110 disseminules belonging to 8 species came from 26 males, and an account of the females' importance in carrying disseminules is discussed. More disseminules were recorded in the dry than in the wet seasons. Female hares showed nonsignificant seasonal differences in number of disseminules as well as nonsignificant differences in the number of species of plant disseminules they carried. The males showed no seasonality in their zoochorus activity. The significance of climatic, vegetative, edaphic and other environmental factors in influencing the seasonality and magnitude of plant propagules and its bearing on zoochory is reported.

More grass disseminules than herbaceous ones were carried by hares, and *Hyparrhenia filipendula* and *Tribulus terrestris* were the grass and herb species most frequently carried. The amount of ectozoochory was found to be influenced by the presence of zoochorus features other than abundance of disseminules.

INTRODUCTION

The requirement for plants to disperse from the parent stock and the various methods and mechanisms of plant dispersal were discussed by Ridley (1930). The mechanisms whereby animals may effect the dispersal of seeds are many (Grime 1979). Ridley (1930) and later, van der Pijl (1972) described and classified seeds and fruits which are adapted for dispersal by animals.

Grime (1979) discussed the large number of adaptations of many different plants which facilitate transport of the seed by particular animals. He differentiated between dispersal mechanisms (e.g., burrs, hooked fruits, glutinous seeds) which involve attachment to the exterior of the animal (ectozoochory) and those in which the disseminule is attractive and eaten by the animal (endozoochory).

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In the course of studies of general ecology of the hares and the effects of prescribed burning of grassland habitat on them, we found that hares were carrying plant disseminules externally. Because information on the role of mammals in zoochory is rather scanty (McClintock 1965), we decided to investigate this aspect of the hare's ecology.

The hare zoochory literature deals primarily with temperate species (Watt cited by McClintock 1965, Flux 1967, Ridley 1930, Tomich *et al.* 1968). All these investigations reported low incidences of ectozoochory by the hares studied. Agnew and Flux (1970) found higher levels of ectozoochory by Cape hare *(Lepus capensis L.)* in Kenya than reported in the temperate regions (Flux 1967, Ridley 1930, Tomich *et al.* 1968). They attributed this to differences in the flora rather than fauna in the study areas. This paper reports on the role of *Lepus crawshayi* de Winton (Eltringham and Flux 1971) in ectozoochory in Queen Elizabeth National Park, Uganda. The study was conducted from October 1981 to the end of September 1982.

STUDY AREA

Queen Elizabeth National Park (formerly Ruwenzori National Park), 1978 km² in area, is found in the extreme southwestern corner of Uganda between latitudes 29° 45'E and 30° 15'E and longitudes 0° 30's and 0° 15'N. It occupies the floor of the western arm of the Great East African Rift Valley. The Park has an undulating topography that varies from 900 m to 1450 m a.s.l. The climate is equatorial with bimodal rainfall peaks, with 2 wet (March-May — long wet and September-November — short wet) and 2 dry (December-February — long dry and June-August — short dry) seasons. Detailed information on the climate of the Park is given in Lock (1967) and Spinage (1968). The vegetation comprises several grassland mosaics ranging from the hippo-grazed *Sporobolus*-mosaics along the lakes and Kazinga Channel shores to the tall fire-adapted *Hyparrhenia-Themeda* grasslands (Edroma 1975). The grasslands are dotted with bushes of *Capparis* spp., and in some places bushes of *Acacia* spp. have thickened into woodlands. In the south central portion of the Park which receives high rainfall, is the Maramagambo tropical rain forest. Further details of the vegetation have been given by Langdale-Brown *et al* (1964), Osmaston (1971), Lock (1967) and Field (1968).

MATERIALS AND METHODS

The hares were collected monthly at night by shooting with a .410 calibre shotgun using a hand-held 100-watt spotlight. The dead hares were packed separately in polythene bags with tags bearing the number, date, time, location and habitat and then transported to the laboratory. In the laboratory, the hares were emptied onto large sheets of white absorbent paper to mop up any dew on the fur, then vigorously combed using a fine fur comb and thoroughly searched for any plant materials on the body. The disseminules were put separately into labelled vials for identification and counting.

The hares were then sexed, and weighed and standard body measurements were taken before dissecting for other studies. As many of the different habitats as possible were sampled, which included open, short, and tall grasslands, woodlands, and forest edges.

Data were gathered on the number and sex of hares carrying disseminules, total number of disseminules, and disseminule species diversity. The number of months a particular species was observed is referred to as the frequency of occurrence of that species. The statistical analyses were based on Steel and Torrie (1960), and $P \leq .05$ was accepted as significant.

RESULTS

Throughout the 12 months, 96 hares were examined and 62 (64.6%) of them had disseminules on their fur (Table 1). The number of disseminules on the hares in the dry season was significantly greater than in the wet seasons, accounting for 74.0% of the annual total of 434. In the wet season, 109 disseminules were collected, 25.1% of the total. The greatest monthly total of disseminules was recorded in February, at the end of the first long dry season, and the lowest occurred in the middle of the first long wet season (April 1982) with only 9 (2.1% of total).

The highest number of disseminules, 13 out of a total of 23 (56.3%) was recorded in the middle of the second short wet season (October 1981) and the lowest, with only 3 species (13.0%), was in May 1982 in the first long wet season. However, there was no seasonal trend in the total number of species represented ($X^2 = 1.27$, d.f. = 3, $P > 0.05$) (Table 1).

Table 1.Seasonality of ecotzoochory by hares in Queen Elizabeth National Park, Uganda, October 1981 — September 1982. Each season had three sampling periods.

Seasons	Total Number of Hares Examined	Number of Hares Carrying Disseminules	Total Number of Disseminules	Mean Disseminule Per Hare 'S.E.	Total Plant Spiecies Represented
1. Short Wet	28	10	70	2.6±0.0	15
2. Long dry	21	19	181	9.9±3.2	12
3. Long wet	22	9	39	2.0±0.7	7
4 Short dry	25	24	144	5.7±0.8	12
TOTALS	96	62	434	4.5±1.5	23

The incidence of disseminules on the hares was 93% in the dry seasons and 38% in the wet seasons (Table 1). There was a nonsignificant relationship between the number of hares examined and those that carried disseminules per month ($r = 0.33$, $P>0.05$). This meant that the dispersal of disseminules by hares was density independent. There was also nonsignificant relationship between mean number of disseminules per hare per month and number of species represented per month ($r = 0.55$, $P > 0.05$). This showed that some plant species are better adapted for hare dispersal or that some species produced more disseminules than others (Table 3).

Table 2. Numbers and species of plant disseminules by seasons, on female and male hares in Queen Elizabeth National Park, Uganda, October 1981-September 1982.

	MALES			FEMALES		
	Number of Hares Carrying Disseminules	Total Number of Disseminules	Total Disseminule Species	Number of Hares Carrying Disseminules	Total Number of Disseminules	Total Disseminule Species
1. Short wet	5	31	6	5	39	9
2. Long dry	5	17	2	14	163	10
3. Long wet	6	29	3	3	10	4
4. Short dry	10	33	5	14	111	7
TOTALS	26	110	8	36	323	14

Table 3. Plant species, number and type of disseminules involved in ectozoochory with their frequency of occurrence based on 96 hares shot in Queen Elizabeth National Park, Uganda, October 1981 - September 1982. The nomenclature of shrubs and herbs follows Lind and Tallantire (1975) and for grasses, Clayton (1974).

Plant Species	Frequency of Occurrence of Species (Months)	Number of Disseminules	Type	% of Total Number of Disseminules
A. GRASSES				
1. *Hyparrhenia filipendula* (Horst) Stapf	5	65	seeds	15.0

2. *Tragus berteronianus* Schult.	6	54	seeds	12.4
3. *Cenchrus ciliaris* L.	7	44	seeds	10.1
4. *Themeda triandra Forssk.*	5	29	seeds	6.7
5. *Heteropogon contortus* (L.) Roem. & Schult.	5	28	seeds	6.5
6. *Eragrostis cilianensis* Lutati	3	26	seeds	6.0
7. *Chloris gayana* Kunth	4	19	seeds	4.4
8. *Brachiaria platynota* (K. Schum.) Robysn	4	17	seeds	3.9
9. *Aristida adoensis* A. Rich.	1	11	fruits	2.5
10. *Eragrostis tenuifolia* (A. Rich) Steud.	3	8	inflorescence	1.8
11. *Harpachne schimperi* Hochst. ex. A. Rich.	1	7	spikelet + seeds	1.6
12. *Eragrostis exasperata* L.	2	4	seeds	0.9
13. *Panaicum brevifolium* L.	1	3	inflorescence	0.7
14. *Microchloa runthaii* Dev.	4	4	inflorescence	0.2
B. HERBS/SHRUBS				
15. *Tribulus terrestris* L.	3	43	fruits	9.9
16. *Oxygonum sinuatum* (Meisn.) Dammer	4	39	fruits	9.0
17. *Alysicarpus rugosus* (Willd.) DC.	2	14	seeds	3.2
18. *Achyranthes aspera* L.	2	7	seeds	1.6
19. *Clematis hirsuta* Guill. & Perr.	3	7	seeds	1.6
20. *Urena lobata* L.	1	4	fruits	0.9
21. *Triumfetta macrophylla* K. Schum.	1	2	fruits	0.5
22. *Sanicula elata* D. Don	1	1	seeds	0.2

Forty-five female hares made up 46.9% of the total collected. These carried 324 disseminules accounting for 74.7% of the total (Table 2). The highest number of disseminule species on an individual hare was 10, 43.5% of the total number of species, on a female hare in the long dry season. Twenty percent of the females carried no disseminules as compared to 49% of the males. Females show nonsignificant (χ^2 =3.7, P>0.5) seasonal differences in number of disseminules as well as non-significant differences (χ^2=3.3, P>0.05) in the species of plant disseminules they carried (Table 2).

Fifty-one (53.1%) of the hares collected were males, and these carried 110 disseminules, accounting for 25.3% of the overall total (Table 2). The highest number of disseminules recorded on a male hare was 17 at the end of the short dry season and the highest number of disseminule species was 6 accounting for 26.1% of the total annual disseminule species (n = 23) at the beginning of the long wet season of 1982.

Twenty-two plant species were identified on the hares, with a total of 436 disseminules. Fourteen of the species were grasses which made up 64% of the species involved with a total of 319 disseminules or 73% of the disseminules recorded. Herbs and shrubs made up 36% of the species involved with 8 species represented. The herbs and shrubs totalled 117 or 27% of the disseminules (Table 3).

Among the grass species, *Hyparrhenia filipendula* was the most common, with 65 seeds (15% of the total disseminules) found in 5 months. *Cenchrus ciliaris* was found in 7 months, *Tragus berteronianus* in six and *Panicum brevifolium, Aristida adoensis* and *Harpachne schimperi* each occurred in only one month (Table 3).

Tribulus terrestris, a grassland herb, was the most common of the herbaceous plant disseminules encountered, with 43 fruits representing 10.0% of total disseminules and occurred in 3 months of the study. The commonest herb, *Oxygonum sinuatum* occurred in 4 months and contributed 39 fruits, 9% of the total disseminules (Table 3).

DISCUSSION

Ectozoochory by hares as demonstrated in this study could have tremendous impacts on local distribution of some plant species in the Park. Sixty-four percent of the hares examined carried disseminules on their fur regardless of the season. These disseminules are dropped off daily as the hare grooms its fur. Some areas of the Park at certain seasons of the year carry from 5-12 hares/ha, and thus their role in the dynamics of the vegetation could be significant.

The hares in this study area carried a higher number of species than those studied by Agnew and Flux (1970) in Kenya savannahs, although the Kenyan animals carried a higher total number of disseminules

than those from this Park. The higher number of species reported here could be because of differences in plant communities (and possibly soils and climate) in the two areas, and more important still are the behavioural and niche differences between *Lepus capensis* and *Lepus crawshayi* (Agnew and Flux 1970). *Lepus crawshayi* prefers thicker bush as well as grassland (Eltringham and Flux 1971), therefore it is capable of picking up and transporting disseminules within the ranges of the two or more habitats. The presence on *L. crawshayi* of disseminules of herbs, e.g., *Triumfetta macrophylla,* common only along swamp edges, and *Sanicula elata,* a forest herb (Lind and Tallantire 1975), suggests that this species may have a large home range or wide habitat preferences.

The high frequency of *Hyparrhenia filipendula* corresponds to its wide distribution in the Park and its adaptive features for zoochory. The less commonly observed species, e.g., *Harpachne schimperi* (Table 3) were not rare in the Park, but rather lacked the modifications for ectozoochory such as barbs or hooks. This finding agrees with that of Friedman and Stein (1978) who reported the seed dispersal mechanisms of *Anastatica hierochuntinca* to have profound influence on its ecological dispersion through zoochory. Herbs like *Tribulus terrestris* and *Oxygonum sinuatum* are very highly modified for zoochorus life and are seasonally abundant.

The highest incidences of the disseminules on hares occurred in the dry seasons and the lowest registered in the wet seasons (Table 1). The most logical explanation for these seasonality effects is that most annual and perennial plants in the region that have their growth cycles synchronized with the wet and dry seasons, thus have more mature and abundant disseminules in the dry season (Lind and Tallantire 1975).

Possibly the disseminules are removed only "accidentally" as the hare scratches off itching ectoparasites from its body. Studies have reported that burning (which in this Park occurs extensively in the dry seasons) in dry seasons reduces the intensity and extent of infestations of ectoparasites (Bendell 1955, Flux 1972, Clifford *et al.* 1976). Fewer parasites in the dry seasons as a possible result of bush fires, could mean that hares groom less and hence accumulate plant disseminules on the body. Flux (1967) reported that moulting in *Lepus europaeus* Pallas in New Zealand occurs in seasons similar to the rainy seasons in the tropics, and later Agnew and Flux (1970) reported that *Lepus capensis* and *Lepus crawshayi* in the tropics moult in the wet seasons. If this is the timing for moulting of savannah hare, this could further explain the seasonality of the number of disseminules observed.

The species of the disseminules were found to vary little with seasons. This could have been because of the widely scattered collection locations in the Park or due to the local variation in microclimate, vegetation and soils (Langdale-Brown *et al.* 1964).

The higher incidence of disseminules on female hares of *Lepus capensis* reported by Agnew and Flux (1970) was also the case in *Lepus crawshayi* in this study. The explanation put forward by Agnew and Flux (1970), i.e., that the female hares have less time to groom or tend to live in thicker cover as they tend the young where they encounter more burrs, is plausible but it is open to further investigation. A further explanation could be that females tend to range farther afield, especially when breeding and lactating, to acquire enough food.

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